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Image transmission using visible light communication in data communication

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ABSTRACT

The development of network communication technology is currently emerging rapidly, one of which is the use of LED lights that are not only used as lighting in the room but can also be used as a medium of data communication between users through light media. VLC is the latest innovation in the field of data communication that is currently being developed where light media is used in the process of sending data. The simulation of sending data using VLC can be done on the transmitter and receiver side by using Visual Studio application as an application that can visualize the process of sending data. By using this system, the process of sending data can be seen bit by bit so that the success rate of sending data can be easily seen by the user. system used Arduino Uno as microprocessor. From the test results obtained the success rate of displaying images sent by the transmitter is 100% with a maximum distance of 50 cm with an image capacity of 20 KB with a delivery time of approximately 30 minutes.

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1. INTRODUCTION

Communication is a basic need for human life [1]. Basically, humans need technology that can support communication for transmitting information [2]. At this time LED lights are not only used as lighting devices but can also be used as a data communication medium between users through the use of light media [3-5]. The technology that utilizes Led lights for data communication is Lifi (light fidelity). Lifi needs are very aligned with the needs of users who have high mobility because Lifi has better bandwidth, high efficiency, availability and security capabilities than wifi [6-8]. Lifi technology is often also called VLC (visible light communication) that is technology uses the light as transmitter that can transmit in the air and have the appropriate photodiode as the receiver [9, 10]. Some studies that discuss data transmission using the VLC method are sending image data using OOK (on-off keying) modulation to transmit color images based on Raspberry Pi [11]. in this study the system can send images, but the images received are still not perfect so image has to repair to get the optimal image display on the receiver side. Another study that discusses image delivery based on VLC is an image delivery system using PIC16F877A as its microcontroller. in this system the accuracy of image data delivery reaches 99% (12). the next research is related to sending data, text and images from one PC to another using LED media bulb. in this system using hyperterminal for the process of sending data with a baud rate of 9600 Kbps. as for the farthest distance that can be achieved when sending a signal is 4 meters [12].

In data communication using the VLC method, the distance factor, LED light intensity and environmental light intensity are very influential for the success of sending data from the transmitter to

the receiver, where at a distance of 2.5 meter, the proper frequency used is 600 Hz to 25 KHz. [13]. Because of VLC using LED for data transmission so the communication of VLC just for shorter range data communication [4, 14] In addition to increasing the success of data communication using VLC, the VLC communication system must use wide bandwidth access by minimizing the presence of noise [15]. As for the advantages of using light as a transmission medium is a data security factor, LIFI is part of wireless communication that using electromagnetic wave for transmission data, in this case, lifi can be used as a solution to avoid interference and congestion when sending wireless-based data [16, 17]. The other advantages of lifi is high speed of data transmission, because lifi use the light spectrum that has a higher frequency than radio waves for transmission of data [18, 19]. Another advantage associated with LIFI is the high speed of sending data, so this system strongly supports high quality audio and video communication in real time with a maximum distance of 3 meters [5]. Due to the limited transmission distance of the transmitter and receiver, the VLC method is suitable if used in an indoor room [12]. As for the international standard governing VLC data communication that uses light as an intermediary, IEEE 802.15.7 [20].

From some of the description above shows that data communication that uses light media to transmit data becomes very important in wireless-based communication compared to using radio waves. For that we need a system that has a good and easy user interface for displaying the process of sending data in real time based on the number of bits sent from the transmitter to the receiver so that the possibility of the number of bits lost during trasnmission can be avoided. Therefore, this paper will discuss the process of sending data using VLC with diode as its intermediary media. By using Arduino Uno as microprocessor that requires input power of 5 volts. And for the monitoring process of sending data each bit in real time both on the transmitter and receiver side, this system provides an application that displays the success of the data transmission process using visual studio [21-23]. Visual studio applications are often used to simulate the performance of a system that will be built so that it is easily analyzed by users [24-27].

2. RESEARCH METHOD

The disadvantage in the process of sending data using wireless media is the longer delivery time compared to using cable media, therefore another media that can transmit data in a short time is based on wireless. Therefore, visible light communication (VLC) can be a solution for sending data. Visible light communication (VLC) is a data communication medium that uses visible light between 400 and 800 THz (780-375 nm) [28]. The VLC module uses Arduino Uno R3 as a Transmitter module and receiver and Light Emitting Diode (LED) lights as intermediary media in sending data. On the Transmitter module side, it will function as the sender of image or image data, the Receiver module will capture the LED light which acts as a data communication signal and then the signal will be processed by Arduino Uno to be displayed on the receiver's monitor screen.

In Figure 1 shows the topology of data communication using Arduino Uno for VLC system. At the Figure 1 shows that Arduino Uno functions to process data processing before the data is sent by the laptop transmitter through the LED and perform data processing again before the data is displayed through the receiver monitor. When sending data using visible light communication, the transmitter and receiver position are in the line of sight (LOS), so that the beam of light from the LED can be captured by the photodiode as shown in Figure 2.

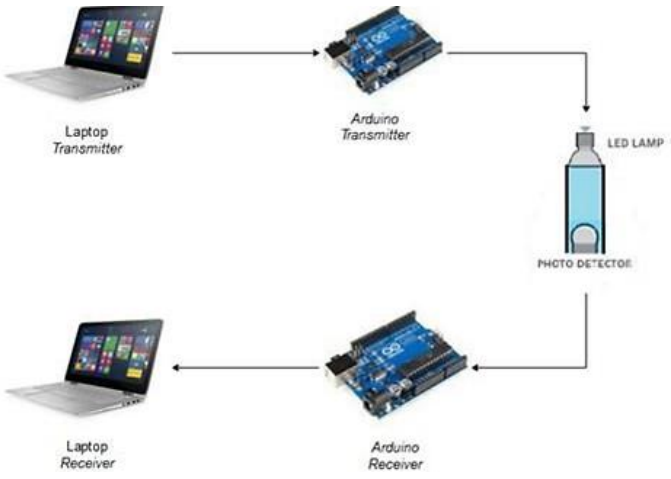

Figure 1. The Topology of data communication using VLC

Meanwhile Figure 2 shows the data communication system using VLC. In this system the transmitter module connects to the laptop using a serial cable and receiver module which is also connected to the laptop using a serial cable then the user will communicate with each other using LED light emitted by the transmitter and receiver will capture the signal sent by the LED light by sending image data in the form digital signals 1 and 0. While in Figure 3. Shows the transmitter module and receiver circuit that will be used asl VLC using the Arduino Uno R3 as a microprocessor.

In Figure 3 shows the range of VLC modules using Arduino Uno as the microprocessor. In this series the system built consists of Arduino Uno R3 here functions as a microcontroller based on the Atmega328P chip as a transmitter and receiver module [29]. Serial cable serves to connect Arduino with a laptop, super bright LED serves as a light source to be modulated, photodioda functions as a light receiver modulation of leds, jumper cables as a link between Arduino and devices such as LEDs and photodiodes, and TR 2N3906 transistors on the transmitter and TR 2N2222 on the receiver module which functions for signal modulation sent by the transmitter and received by the receiver.

Figure 2. Data communication using visible light communication

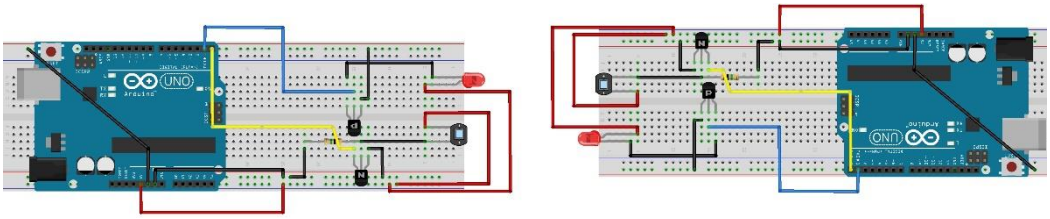

Figure 3. Schematic design of prototype system

3. RESULTS AND ANALYSIS

When the transmitter sends data through the LED, the system must be precisely aligned with the receiver for LOS scenario and there is no barrier [30, 31], so that all light intensity can be captured by the photodioda so that Arduino can display all the information sent by the transmitter as shown in Figure 4. Figure 4 shows the process of sending images using the VLC module. In this process the photodiode is used as a transmission medium in sending data. So that the position of the photodiode transmitter and receiver must be in a line of sight (LOS). The process of changing analog signals into digital signals is carried out by Arduino Uno, then the next stage occurs changes in the digital signal to light that will be sent through a photodiode. The applications built using visual studio can show information on the number of bytes of an image sent through VLC media along with the total time needed to send the data. In Figures 5 and 6 shows the testing process of sending images with a transmitter distance to a 10 cm receiver using 9600 baudrate. In this testing used image data with a size of 22.2 KB. From the test results, it can be seen that the time needed for sending data from the transmitter to the receiver is 3 minutes 34 seconds. The use of visual studio applications can describe the process of sending data in real time so that users can see the process of transmission data. as shown in Figures 5 and 6.

Figure 5 shows the data sender application. From the application the process of sending data begins with the selection of ports and baudrate which will be used for sending image data. While in Figure 5 as shows the application on the side of receiver. Through a monitoring application sending data using VLC, the user can monitor every bit that is being sent, so that the sending failure process can be avoided.

In Figure 6 shows the application used to display images received by the receiver. In this application the image will be displayed on the receiver's side if all the bytes have been received by the receiver. If the number of bytes received by the receiver is different then the system cannot display the image sent by the transmitter. So, by using this application the system can show the success rate of sending images by the transmitter through the VLC. While the time information section of the application shows the length of time needed to send an image data via VLC. The length of time required to send an image can show

the performance of a VLC system that is built. So, the user can evaluate the VLC system that was built through the time information displayed on the application.

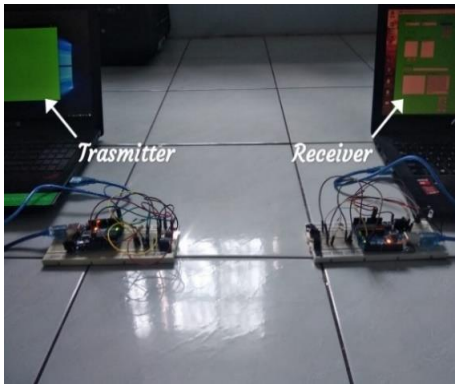

Figure 4. Image transmission using VLC modul

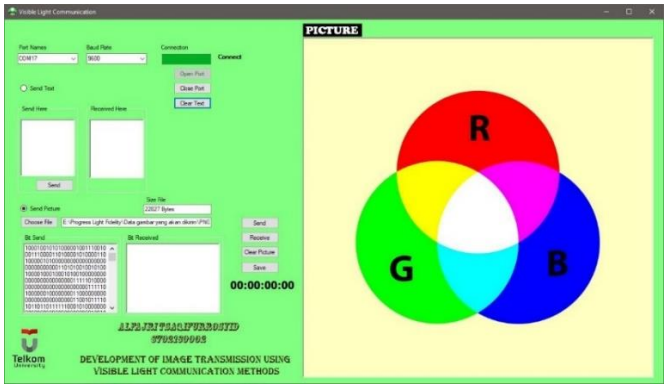

Figure 5. Aplication of image transmission

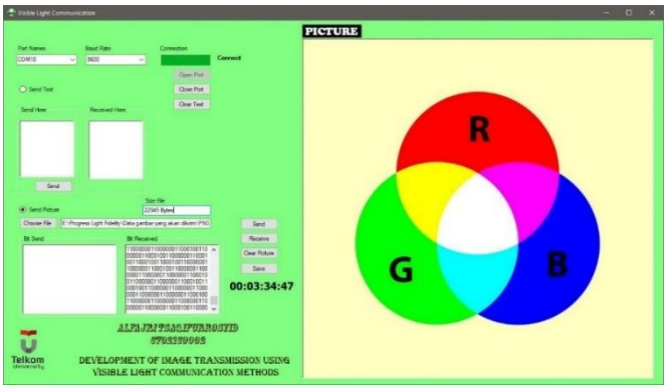

Figure 6. Application of recever

In Figure 7 shows the time needed to send images in jpg, png and gif format with a range of distances of 10-20 cm. In Figure 7 shows the process of sending images with variations in image size and variations in the distance between the transmitter to the receiver. In the picture shows that images with jpg format with a size of 3.11 KB require delivery time of 30 seconds, while images with a size of 11.8 KB require delivery time of 1 minute 53 seconds, and images with a size of 37.5 KB takes 6 minutes, and images with 81.4 KB takes 13 minutes. For measuring images with a png format with a size of 7.86 KB, it takes delivery time 1 minute 15 seconds, and images with a size of 16.6 KB takes 2 minutes 39 seconds, matching images with image size 37.2 KB takes 6 minutes, and if the image has a size of 106 KB then takes 17 minutes. To measure images in a format with a size of 6.06 KB gif takes 1 minute, while images with a size of 23.6 KB takes 3 minutes 50 seconds, and images that have a size of 37.8 KB takes 6 minutes 5 seconds and images with a size of 72.8 KB require delivery time 11 minutes 40 seconds. From these data shows that the greater the size of the data to be sent, the longer the time needed to be. In Figure 8 shows the process of sending images with the distance between the transmitter and receiver is 30 cm.

From Figure 8, the VLC system can still send images when the transmitter and receiver are at a distance of 30 cm. From the graph shows that the data transmission requires a longer time if the transmitter and receiver distance is further by using a 4800 baudrate. While in Figure 8 shows the image sending system uses the VLC module with a distance between transmitter and receiver 40-50 cm. In Figure 9 shows that the VLC system can still send images with the largest size of 23.6 KB, so if sending images larger than 23.6 KB the system will fail so that the image cannot be displayed by the receiver application.

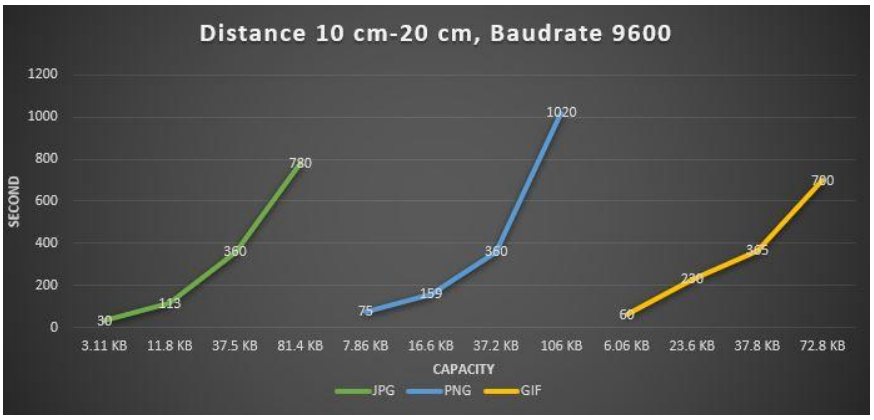

Figure 7. Performansi system for variation image transmission

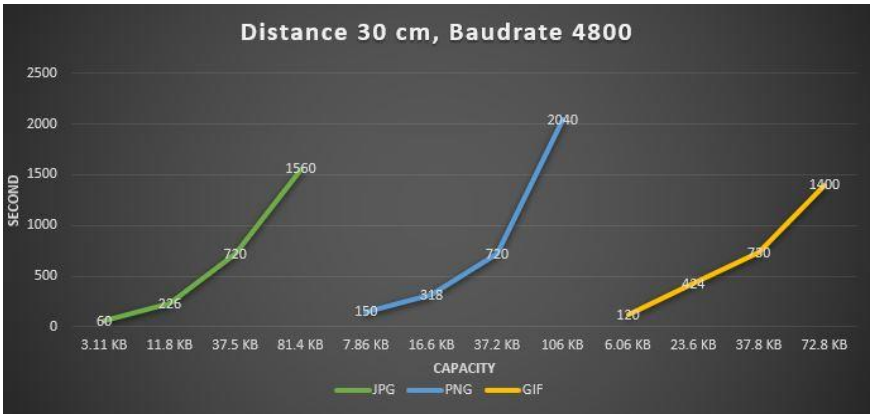

Figure 8. Data transmission in the distance 30 cm

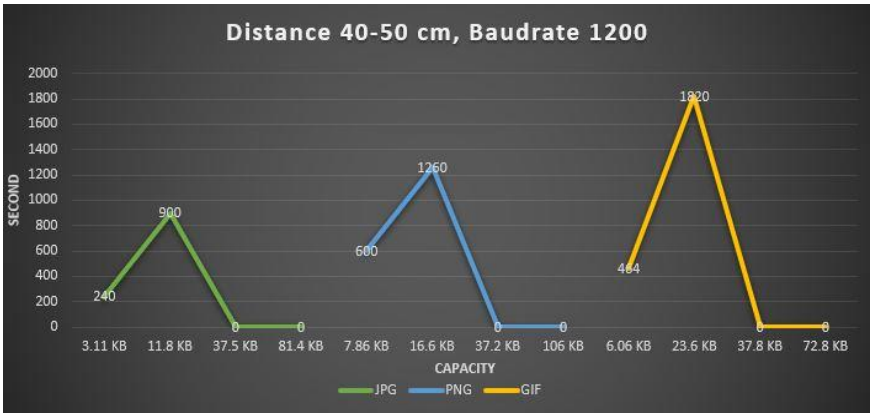

Figure 9. Image transmission in the distance 50 cm

4. CONCLUSION

VLC application that uses visual studio successfully shows the success rate of sending data from transmitter and receiver in every bit so the user can monitor every bit that is transmitted through the light media so that the process of data transmission failure can be avoided. The VLC system that used the Arduino Uno R3 as a microcontroller successfully sending image data in the format of jpg, gif and png with a maximum file size of 20 KB at a distance of 50 cm. while the time needed to display the image on the receiver side is 30 seconds with a baudrate 1200. This shows that the longer the transmitter to the receiver the longer the time needed will be. In addition to sending image data with long distances, the process of sending images must be

carried out using a smaller baudrate. Based on the experimental results above, it shows that the VLC system that was built shows a good level of performance because the system succeeded in sending all types of image data sent by the receiver.

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